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Development of a Magnetically Levitated Linear Motor

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Magnetically levitated material transport systems are a preferable replacement for regular material transport systems in clean room operations. The levitated machine has no mechanical contacts between the stator and the mover, which leads to frictionless movements. The absence of friction eliminates the need for lubrication between the stator and the mover. Furthermore, mechanical machine components with friction produce and propogate undesirable vibrations and noise. The friction between the stator and the mover can break small particles from the machine and these particles can contaminate a clean operating environment. Moreover, the lubrication chemicals used between moving machine elements can release particles to the operating environment. Initial investigations into a novel linear motor having a soft magnetic steel mover in an Aluminum shell and circular driving coil pack revealed possible thrust force while having near zero lateral forces. The mover can be levitated using hybrid electromagnets (HEMs) and near zero power operation can be realized for levitation. Nonlinear behaviour of HEMs are identified using FEM methods and used to model system dynamics of the motor and to design levitation and driving controller. The novel design offers flexibility for full 360-degree rotation of the mover using a regular brushless motor as an attachment. Therefore, it is expected to analyze the design further using 3D FEM methods to investigate feasibility and possible improvements of the initial model.

Keywords: FEM Analysis, Linear motor, Magnetic levitation, Nonlinear system modelling